# WHAT ARE PRESCHOOL TEACHERS'PERCEPTIONS ABOUT PROFESSIONAL DEVELOPMENT IN SCIENCE CONTENT AND PEDAGOGY WHEN USING A NOVEL APPROACH?

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Dedication

To my mother, you have always held the vision of this day. I appreciate you more than you ever will know. My sweet husband, I am so blessed to carry your last name. For this name carries strength, love, and determination. Thank you for your endless support! Grandma, I know you are not here in the physical, but I feel your presence every day. Zoe and Harry, know that I am already holding a vision for you both. Not even the sky can stop the two of you, mommy loves you!

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## Abstract

**Background:** Many variables determine student success in preschool, as it relates to STEM knowledge and engagement in later school and career development. Students need a well-rounded, engaging, and rigorous curriculum (Anderson, 2006). Second, teachers must be properly trained in STEM pedagogy and content (Marcum-Dietrich, 2011). **Purpose:** The study investigated how ongoing professional development affects teacher knowledge, confidence, and skillset (Piasta, 2012) while using a new classroom approach. The initial STEMscopes Early Explorer was designed to provide science education to low socioeconomic students. STEMscopes is an international Pre-K -12th-grade digital science curriculum. The curriculum offers foundational science content, hands-on learning, and integration of technology, engineering, literacy, math, and arts. STEMscopes Pre-K curriculum allows teachers access to substantive STEM content to help engage and deepen their students' understanding of science. **Methods:** A qualitative research study using a case study approach addressed the research question, What are preschool teachers' perceptions about professional development in science content and pedagogy when using a novel approach? A case study method allows for the discovery and development of theory, based on the experiences and perceptions of study participants (Creswell, 1982). The study examined archival teacher interviews and questionnaire data regarding teacher perceptions of ongoing professional development as new and experienced pre-K teachers begin to implement a science-based program--STEMscopes Early Explorer. The original data was collected through interviews, observations, lesson logs, surveys, and professional development session. All pre-K teachers in a central school district in Texas participated in the study. All 51 participants were primary level teachers, with a wide range of experience. The district required all of

their pre-k teachers to participate in the study. Of the 51 teachers, 3 were selected for this archival study. These 3 teachers offer a range of teaching experience, age, gender, and ethnicity. The data sources consisted of two rounds of individual teacher interviews and a Preschool Teacher Attitudes and Beliefs towards Science Questionnaire (PTABS) (Bell, 2014). Coding software was used to identify themes and their implications related to the research question. The teacher interviews were transcribed into a word document. After multiple reads through the interviews, particular themes and then nodes were developed. The nodes provided themes and emerging patterns for the fall and spring data Identifying the nodes and themes for the questionnaire was also a similar process. The questionnaire data highlighted more comparison in perceptions between the three teachers. Two of the three teachers believed there is enough time in the day to teach science. **Results:** Findings revealed 1) teachers value professional development that is created with teacher input, as it allows them to feel heard; 2) an improvement needed in current professional development is to provide teachers with more collaborative time with peers, and 3) teachers desire more hands-on modeling and content training. After two professional development sessions, teachers were able to provide feedback in needing more collaboration and modeling. As a result, STEMscopes made adjustments to the last two sessions in order to meet the needs of the teachers. Through teacher's usage of STEMscopes and undergoing 30 hours of professional development, they provided feedback to enhance the product and professional development. Pre-K teacher's desire to teach science when professional development is tailored to their needs, allows them support, and time to practice new strategies. The findings are significant as they illustrate the importance of a highly effective curriculum, but they also highlight the importance of ongoing professional development that is customizable and flexible to meet teachers'

needs. **Conclusion:** The findings of this study will help to extend current research pertaining to ongoing professional development. Teachers' perceptions of professional development in science and pedagogy are centered around teacher-led professional development. Teachers should have an ample amount of time to implement what has been learned. As teachers are utilizing new material, they should be observed and provided feedback in order to create a cycle of learning, practicing, and improving.

## Table of Contents

# Chapter I

## Introduction to Literature

Studies have shown that minority Americans are less likely to become doctors or engineers due to inadequate preparation for college. As a result, 35% of students attend high schools that don't offer calculus or physics courses which are both a foundation for a well-rounded STEM education (Allen, 2017). This lack of preparation limits the number of minorities that become engineers, which limits our country in continuing to be a global leader (Allen, 2017). If we begin STEM education in preschool can lead to a greater likelihood of student success in STEM careers (Allen, 2017). As teachers begin to prepare students to think like engineers, for true success there must be a viable curriculum and professional development that accompanies it.

In a mathematics professional development study, teachers participated in 8 hours of mathematics professional development for the school year (Duncan, 2007). No Child Left Behind, Title II funds require professional development to be sustained, intensive and content focused. Additionally, it should correlate with state standards, improve teachers' content knowledge, advance instructional strategies, and be evaluated for effectiveness (Duncan, 2007). Teachers who receive 49 hours of professional development can boost student achievement by 21 percentile points (Duncan, 2007).

Authentic professional development should allow for the planning of lessons, using the lessons and then revising lessons with a professional (Marcum-Dietrich, 2011). Teacher confidence and attitudes about STEM teaching can aid in successful student

learning. (Nadelson, 157) Could quality initial training and ongoing support better help the teacher to be more successful in implementing a STEM based curriculum?

**Personal Narrative**

School has always been an integral part in my life. For many years, I didn't believe I was any good in it. In fact, it wasn't until college that I realized I was college material. I even went as far to say, "there's no way I'm going for a masters and definitely not a doctorate." There was always this voice from my mother demanding that I would do both. My mother has always been my biggest advocate for education. As a 17-year-old new parent, she had no clue of what she was doing, but she knew education was important. I can remember being 4 or 5 years old and sitting in the lecture hall at the University of Houston. It took my mom over 10 years to finish her bachelor's in marketing, but she did it.

As I became school age, we both learned about good schools and not so effective schools. Thankfully, I ended at Lamar High School which would help lead me to one of my biggest accomplishments. As my mother continued learning the education system, she helped my sister get a scholarship to The Kinkaid School (a well-known private school in the Houston area) for middle and high school. As a result, my sister is currently an engineering student at the University of Miami.

With education at the forefront, I entered my senior year of high school knowing that college was the only option. At the time, I was interested in studying journalism. I was a student at the Chronicle Classroom, which is a partnership between HISD and the Houston Chronicle, for high school seniors as yearlong internship. It was in this program that my teacher and biggest advocate assisted me in applying for the Gates Millennium Scholarship. The year I applied, there were 14,000 applicants, and only 1,000 students

would be selected. It was also during this time that tragedy struck my family, and my stepfather had been murdered. Yet, during this time favor was still upon me. I became one of the 1,000 selected. Which meant, my bachelors, masters and doctoral degree would all be paid for. It was through these degrees, drive from my mother, and teacher advocates that led me to education.

As I begin my teaching career, I learned of a science curriculum company called STEMScopes. After having my daughter, I would begin consulting for them and training teachers throughout the nation. Still not quite sure of my passion, I began learning about the company's Early Childhood curriculum that was used for preschool students. While learning, I couldn't help but think of my daughter, and in a flash the cycle of education is continuing. As I prepare to finish my doctoral degree, I hope to create a STEM preschool for low income students, just as I once was.

**Statement of the Problem**

Professional development is required of all teachers across the United States. Its purpose is to improve the learning of educators in hopes of improving the student's education (Avery, 2013). There are many ways in which teachers can participate in professional development such as; conferences, workshops, professional learning communities, etc. As teachers learn new practices, the expectation is that professional development will be implemented in the classroom to improve the education of the child. Many teachers believe professional development is more of a requirement than it is a benefit. Professional development has a reputation to not always being effective (Avery, 2013). The ineffectiveness can be a result of professional development that takes place in silos. Meaning, teachers need practice and ongoing support with the new information that is gained from one workshop to the next. It would be more effective for teachers to have a set professional development plan that is structured around the teachers needs throughout the school year. Which means teachers are not necessarily learning new techniques to take back into the classroom. When implementing a new curriculum, it's important that professional development is effective, and support is ongoing (Avery, 2013).

The problem of practice being addressed in this study is the professional development of the STEMscopes Early Explorer program. STEMscopes is a leader in STEM education. Rice Elementary Model STEM Lab (REMSL) is a grant based professional development program at Rice University (Alonzo, 2016). During this time, the program focused solely on working with Houston teachers to improve their science pedagogy (Alonzo, 2016). Through working with teachers, there became a need for a solid science curriculum that could engage the students through hands-on experiments.

These experiments would need to be cost effective due to the low SES population that these teachers served (Alonzo, 2016). Additionally, the experiments would need to be completed in a reasonable amount of time. Out of this, STEMscopes was created for Kindergarten-12th-grade (Alonzo, 2016).

In 2014, the company realized the need for preschool curriculum that would easily mesh in a current preschool classroom (Bell, 2015). This would birth Early Explorer, a center-based curriculum that infuses STEM, reading, writing, drama, formative and summative assessments. In the 2014-2015 school year, STEMScopes conducted an Implementation Study with a central Texas school district (Bell, 2015). This curriculum is intended for preschool students ages 3 to 4 in classrooms across the nation. The science-based curriculum has integrated Math, Science, and Reading in order to help students be successful as they move into Kindergarten (Bell, 2015). The company has research information about the types of professional development that was provided to teachers to help them implement this curriculum in the classroom (Bell, 2015).

## Research Question

What are pre-K teachers' perceptions about professional development in science content and pedagogy when using a novel approach?

## Rationale

Most elementary teachers have little background knowledge about teaching science which can cause their confidence in the subject to decline. As a result, this declines the amount of STEM teaching and learning that takes place in the classroom (Nadelson, 2013). The nature of a STEM curriculum really requires teachers to have continuous professional development. Meaning, teachers will attend workshops, utilize the learned strategies, and reflect on their practice in time for the next workshop. An effective curriculum should challenge students to engage in authentic applications while utilizing inquiry (Nadelson, 2013). For a teacher to feel confident in equipping the students to do these things, the teacher must be provided the instruction on how to do so. The teacher receives their instruction through professional development workshops. These workshops should offer support to a teacher throughout the school year. Currently, teachers experience professional development as the school year begins and after winter break. Teachers experience an overload of information in the workshops but receive little to no support after the workshop has concluded.

Effective professional development has the ability to help teachers learn exactly what engineers do. As teachers go back to the classroom, they are better able to encourage students to be engineers (Avery, 2013). Effective professional development includes; research, philosophical focus, standards-based curriculum, collaboration amongst STEM disciplines, and an effective professional development model just to name a few (Avery, 2013). Utilizing the STEM Teaching model or Engineering Design Process during training is what helps teachers to effectively model back in the classroom.

Through mini lessons and mini challenges students can better process the standards that are being covered (Avery, 2013). Supportive professional development understands the teacher's needs, respects their input and is organized (Avery, 2013). While group work requires more time and may cover less material, it enhances student's ability to solve problems (Avery, 2013). STEM professional development should help teachers plan their own standards-based STEM lessons. Lastly, STEM professional development should help teachers determine how to integrate appropriate Science, Technology, Engineering and Math.

I believe that professional development improves teachers attitudes towards implementing STEM curriculum. As a result, ongoing professional development ensures that teachers feel supported, which directly create success in the STEM curriculum. For my problem of practice, I plan to analyze the archival data in order to understand teachers attitudes throughout the curriculum implementation and ongoing professional development.

# Chapter II

## Review of Literature

My research topic is to explore preschool teachers attitudes towards professional development and how those attitudes contribute to student's success. Specifically, this topic will explore the attitudes towards science content and teaching science and how it helps students succeed. Many teachers believe professional development is more of a requirement than it is a benefit, in fact, professional development has a reputation of not always being effective (Avery, 2013). When implementing a new curriculum, it's important that professional development is effective, and support is ongoing (Avery, 2013). My research question examines, what are preschool educators' perceptions of professional development in science content and pedagogy?

The major themes that will be explored are professional development, teaching science and science as a content area, general preschool and how science is taught in preschool, STEM as a broader category, STEAM, and equity in science teaching.

**Professional Development**

Teacher turnover is a prominent issue for all school districts, especially low-income and urban schools. This has raised the question of how should schools prepare, support and enable teachers to build satisfying and sustainable careers in education (Anderson, 2006)?

Understanding teachers' perceptions on professional development could offer insight on retaining teachers. Workplace conditions and teachers' attitudes can shape their beliefs about the teaching profession. (Anderson, 2006). As a result, this information can help universities better prepare their students for careers in teaching. Universities can support through a well-developed curriculum to support current teachers concerns in order to keep them in the teaching profession (Anderson, 2006).

Professional learning communities is an additional factor of teacher success. On a campus, professional learning communities can help teachers grow in areas that they are struggling. One way this can be achieved is by providing engaging opportunities of inquiry and dialogue with colleagues of varying experience levels (Anderson, 2006). This task within itself can be complex. Professional development can aid in creating more effective PLCs. However, it requires the professional developers to be aware of the teachers needs in terms of teaching experience and expectations (Anderson, 2006). Once the professional development team better understanding the needs and desires on the campus, the professional development team can develop training in support professional learning communities.

Urban teachers participated in a research study that examined their professional development and the correlation to their teacher education programs at the university level.

The questions raised are; What are teachers' perspectives on the kinds of professional development they are offered, take part in, and desire? How does professional development shape teachers attitude about their work and professional futures? What are the implications for university-based teacher education programs interested in supporting their graduates along a learning continuum (Anderson, 2006)?

The results of the study show, teachers desired effective mentorship, opportunities to observe and be observed by other teachers. In the beginning one's career, they are more concerned with classroom management. After one's first year, teachers want to focus on deepening their instruction. Which implies the importance of understanding where teachers are based on their career cycle (Anderson, 2006). For example, more experienced teachers enjoy professional development and conferences, but really desire the interaction and dialogue with colleagues. As professional developers create experiences based on the campuses, they should take into consideration all these factors to ensure training is not redundant or mismatched (Anderson, 2006).

All participants expressed a true need to collaborate within and across schools. One benefit of collaboration provides support, inspiration and the opportunity to share ideas and really invoke change (Anderson, 2006). Creating a collaborative space at the district and campus level can help with this. professional development descriptions should offer clarity. Teachers can begin mapping what professional development they need based on their career level (Anderson, 2006).

President Obama stressed the importance of STEM education in his 2012 State of the Union address. He discusses our national perception of being a country that leads the world in educating its people (Avery, 2013). By leading the way in STEM, it will open

doors for high-tech manufacturing and high paying jobs. For all of this to be possible it will start with the professional development that teachers will undergo (Avery, 2013).

In the last few years, there has been a change to science standards. The change in standards is to better prepare students for STEM careers. These new national standards are referred to as Next Generation Science Standards (NGSS). These standards are heavily focused on engineering design (Avery, 2013). With such rigorous standards, it's going to require in depth and ongoing professional development (Avery, 2013).

As we prepare our students to lead the way in STEM careers, we must equip our teachers with professional development that promotes a deep understanding of the subject matter along with the best pedagogical practices will yield the best results. In addition, teachers must develop a deeper understanding of science content to better facilitate student learning (Avery, 2013). As teachers begin to promote and encourage students to pursue a career in engineering, the teachers themselves need to be aware of what engineers are and what they do (Avery, 2013). professional development will be the vessel in helping teachers to better understand it.

Engineering design is the process of which engineers go through as they are creating a system. For educators, that are hoping to emulate these experiences in the classroom, they will need to undergo through training in order to effectively teach students through the lens of engineers (Avery, 2013). It is through engineering design that students will encounter all the components that make up STEM (Avery, 2013). Not only will teachers need to understand the Science content but also the technology, engineering and math content as it relates to the challenge. All of which can be taught through professional development.

There are many facets of effective STEM professional development. These facets include: research plans, development of philosophical focus, identification of standards-based curriculum, collaboration amongst STEM disciplines, formulation of effective professional development models, research specific to pedagogical content knowledge, general justification and promotion of engineering and technology education, and effective professional development models (Avery, 2013).

The National Center for Engineering and Technology Education conducted a research study of five classroom teachers that participated in workshops, interviews, documents and classroom observations. The study consisted of two phases a spring and summer workshop. In the spring, there were six 8-hour sessions that focused on setting the scene, creating a cohort, describing the engineering profession, diagnosing abilities, providing foundational instruction, introducing the engineering design method, and communication (Avery, 2013). In addition, the spring phase included STEM applications, activities, pedagogy (of project-based learning, collaborative learning, open-ended problem solving and critical thinking), outside experiences, and guest speakers (Avery, 2013).

Teacher documents such as lesson plans, and design briefs were reviewed to see how teachers had revised their classroom and laboratory practices in comparison to these items prior to completing the program. Classroom observations were used to better understand student behaviors as it relates to STEM learning. In addition, the observations provided a clearer picture of statements made during teacher interviews and how they directly showed what teachers learned during the workshops (Avery, 2013). Last, the workshop documents that provide guidelines to engineering design and instructional

materials were used to analyze teacher statements and what took place during the workshops.

The first finding examined the effects that professional development had on teachers' classroom practices. The study found that each of the teachers mentioned that the workshops provided an educational model that demonstrated how teachers could better integrate problem solving and real-world applications (Avery, 2013).

The second finding highlights some of the challenges with implementing professional development content. First, teachers struggled with evaluating group projects, they really want to learn how to assess group work. Secondly, with the pressure to satisfy the standards in a certain amount of time, it becomes hard to do STEM in every lesson. They really wanted something that could be completed one or two classes. Third, there were not enough authentic engineering challenges. Last, teachers would like more training in developing STEM lessons (Avery, 2013).

The third finding discussed the benefits of incorporating professional development content. Teachers believed STEM professional development helped to facilitate teaching, it increased student motivation for STEM learning, kept students engaged with the subject matter, increased student appreciation for science and math, improved student thinking and problem-solving skills, and improved student learning (Avery, 2013).

The study contributes its success to creating a supportive teacher learning environment (Avery, 2013). Professionalism by workshop staff and coordinators was important to the teachers. It also helped that meals were provided, teacher stipends, willingness to listen to teacher ideas for recommendations for professional development, having good professional development presentation and organizational skills, showing

respect for what teachers do and teach, and providing necessary support for teachers to sustain what they learned through STEM professional development (Avery, 2013).

Utilizing the engineering design challenge as the teaching model truly separated how to teach students problem solving and analytical skills and applying within a real-world context (Avery, 2013). By grounding all workshops in a strong STEM educational philosophy, it really helped the integration of Science, technology, engineering and math at the same time. In addition, its improved student results, versus doing each in isolation.

Both findings focus on the influence that professional development has on the longevity of teacher's careers. More specifically, these studies provide detailed researched methods that can contribute to successful professional development (Avery, 2013).

True professional development will deepen understanding, transform beliefs and assumptions and create a stream of continuous actions that change habits and affect practice (Hirsh, 2003). As a campus leader, it's important to select staff development that aligns with staff members and the desired results for children (Hirsh, 2003). Matching beliefs with appropriate professional development, can help in accelerating a change in behavior and growth.

As schools prepare to close the achievement gaps of their students, leaders must start with the current beliefs and desired results (Hirsh, 2003). The Education Trust's approach to supporting teachers in closing the achievement gap, begins with tapping teacher expertise inside the school and matching them with outside expertise to create a support structure.

This project focuses on developing beliefs and capacities of teachers (Hirsh, 2003). The organization believes that if strong support structures are created for teachers,

even low performing schools will inch upward (Hirsh, 2003). Additionally, utilizing the good teachers on the campus and creating a vehicle for them to help their colleagues, as a result, will strengthen student capacity. Beliefs and skills should be equally considered. For example, schools that provide workshops on diversity and expectations, but fail to equip teachers with knowledge and skills, end up with raised expectations but no improvements in results. Teachers can improve their skills by engaging in discussion about what they are teaching, how they are teaching, and discussing the results with students to show them how to improve (Hirsh, 2003). After evaluating student work, teachers must determine strategies for yielding better results, and share these with students. Schools must be willing to help in supporting teachers in the cycle in order for everyone to be successful.

The Pacific Educational Group believes closing the achievement gap must offer multicultural perspectives and provide students skills for negotiating various cultures. Teachers will undergo training in 'courageous conversation'. In this training, teachers will be asked to stay engaged, speak their truth, and experience discomfort. As teachers adopt these norms, they are able to take them back into their classroom to model for students (Hirsh, 2003). It's important to discuss with student's mutual respect, as it can look different across various cultures. "To show me respect, you must understand my experience. As I come to school each morning, I go through a number of racial tests. If you don't understand where I am coming from, I will feel less safe in your class and distance myself," (Hirsh, 2003).

In conclusion, professional development should aim to do the following: 1. Help students feel trusted and engaged, 2. Strike a balance between teacher control and student autonomy, 3. Cultivate ambition rather than ambivalence toward achievement goals and

success, 4. Teach for student understanding and industriousness and combating disengagement (Hirsh, 2003).

Professional development can create a bridge between low quality programs and high student achievement (Brown, 2016). Many children are participating in Early Childhood Education (ECE) programs that are low in quality as it pertains to learning and instructional environments (Brown, 2016). As a result, policy makers desire to close the gap between high quality instruction and what majority children experience in early education programs by increasing professional development of early childhood educators.

The change of ECE professional development calls for examination of current practices and research. Much of the research is to seek and identify which instructional practices improve teacher and student learning (Brown, 2016). In this research study, ECE professional development is providing insight into ways that professional development can be designed to support early educators' growth and development of young children (Brown, 2016).

professional development learning begins with teacher belief and what they are trying to accomplish in their classrooms (Brown, 2016). Next, the professional development program will be an avenue for teachers to reflect on their ideals of teaching in relation to their professional development goals. Then teachers can develop a plan for change that is rooted in their knowledge and beliefs. professional development is a long-term collective project rather than an individual accomplishment, all members of the learning community should work together (Brown, 2016). Much of the empirical research in examining effective professional development is quantitative in nature and deductive in purpose.

Effective professional development, should have a clear and coherent design, including identifiable outcomes for teachers, be comprehensive and sustained over time, connect to teachers' lives in their classrooms, occur within a learning community of instructional peers, offer specific strategies with immediate applicability for teachers, provide teachers with feedback on newly implemented practices/strategies, offer teachers the chance to reflect and/or self-assess on recent practices in their classrooms, encourage teachers to create and enact new visions for instruction in their classrooms (Brown, 2016).

The research question in this study is: What knowledge and skills should be most important for improving early educators? Additionally, understanding the learning environments that teachers live in should be taken into account.

There were a few primary themes that emerged from the study. First, researchers framed professional development as being a necessary component of an early educators' teaching career. professional development provides these educators with a specific type of knowledge for practice (Brown, 2016). The more knowledge base teachers have about theories and philosophies the more they can see it in action in their students. Second, foundational best practices derive from universities and outside experts as the foundational best practices in early childhood classrooms (Brown, 2016).

Professional development should aim to empower teachers by teaching a set of skills and knowledge effective for their classroom. One teacher gained confidence and a better understanding of the importance of science teaching (Brown, 2016). When the teachers learn tools and strategies that they are able to employ in the classroom it can transform their conceptions and practices. Teachers begin to see themselves as always in

the practice of becoming. Meeting the knowledge and skills requires teachers to practice change based on meeting the needs of young children, their families and communities.

Teachers that participated in these varied studies, appreciated the opportunity to grow professionally by collaborating with other ECE educators and researchers. "Working with colleagues helped teachers alter their practice and working with researchers positively impacted their teaching," (Brown, 2016). Many can view teaching as an isolated act. This research studies allowed teachers to acquire professional skills, but all find camaraderie and knowledge on issues that they are facing in their classrooms (Brown, 2016).

In conclusion, the studies demonstrate that professional development can be transformative and emphasize knowledge for practice perspectives. Missing from this study, is how teachers' practices changed as a result of professional development in their day-to-day interactions. There is also a need for how early educators improve their teaching through their own experiences and expertise which can directly influence the children and their families (Brown, 2016).

**Teaching Science and Science as a content area**

Students begin learning about STEM during their elementary years. Consequently, many elementary teachers have limited background knowledge and confidence to teach STEM (Ejiwale, 2013). Lack of teacher knowledge and more emphasis on Language Arts may directly affect the amount and accuracy STEM learning in the classroom (Ejiwale, 2013). One way to address the limited background and confidence is through effective professional development (Ejiwale, 2013). This study is focused on offering professional development in STEM and researching the effectiveness of the program. The 3-day study will measure attitudes, confidence, and efficacy for teaching STEM. This study illustrates how short professional development interventions can effectively influence teacher confidence and efficacy.

Currently, a teacher certificate only requires candidates to complete two college level science and math courses. Researchers believe two college level courses are insufficient for teaching STEM curriculum (Ejiwale, 2013). To overcome this barrier, professional development must meet the needs of teachers and students. A huge component of STEM is providing opportunities for students to engage in inquiry, authentic applications and active learning (Ejiwale, 2013).

After teachers undergo extensive STEM professional development, one problem still remains, the amount of time available to teacher STEM content (Ejiwale, 2013). It is hard to know if the decline in science instruction at the elementary level is a result of math and reading taking precedence, or teachers attitudes towards STEM negatively impacting their instruction time.

Teachers understanding inquiry and how it's used in the classroom is a huge part of a successful STEM implementation (Ejiwale, 2013). However, it's complexity of

skills, knowledge and creativity can provide challenges to implement (Ejiwale, 2013). Again, this aspect of professional development would require ongoing and reflective sessions.

Teacher efficacy in teaching STEM content largely determines student success. We know that student success is dependent on the teacher's time, enthusiasm, and motivation (Ejiwale, 2013). Therefore, teacher efficacy becomes a larger issue of teacher knowledge and preparedness for teaching STEM content. Teachers with lower efficacy in STEM hold a greater number of misconceptions related to fundamental concepts (Ejiwale, 2013). Teacher in-service or professional development can help to motivate by creating a foundation of STEM principles and boost their efficacy.

Similar to efficacy, is teacher confidence in teaching STEM. There is a strong correlation that low teacher confidence can have a negative influence on student learning (Ejiwale, 2013). Teacher confidence ironically is influenced by their own experiences in K-12 education. Meaning, if teachers had a negative experience with STEM or science education, they are less likely to teach it to their students. As educators, our job is to educate our students regardless of our beliefs. Teachers that undergo additional coursework in STEM it could positively influence teacher confidence. There is a strong relationship between teacher effectiveness, teacher knowledge, and their confidence which can all be addressed through professional development (Ejiwale, 2013).

In addition, teacher attitudes toward STEM can also directly affect the attitudes of their students. In STEM we tend to focus solely on Engineers has they are a huge part of STEM. To improve teachers attitudes about STEM we must first improve their attitudes about engineers. In order to do this, we must first offer exposure to engineers in helping teachers shift their attitude about the profession.

The study was conducted with 68 teachers over a two-year period, teaching grades 1-5. The study utilized lecture, small group discussion, hands-on activities and individual assignments throughout the three-day workshops. The study showed an increase in confidence for teaching STEM, efficacy for teaching STEM and attitude toward engineering. The content and instruction during the workshops helped to increase the participants knowledge of STEM which directly boosted their confidence, efficacy and attitudes about engineering. In addition, focusing on delivery and providing resources to the teachers helped develop a deeper understanding of engaging hands-on and inquiry activities (Ejiwale, 2013). Also allowing teachers time to discuss what they are learning with colleagues and time to apply their learning proved to be very effective (Ejiwale, 2013).

Part of helping teachers address their fear of science content can be addressed during pre-service and university training. Elementary years is when students will form ideas about science, more so whether or not they are interested in science (Marcum-Dietrich, 2011). This is also the time that most elementary teachers feel least prepared or even afraid of teaching science (Marcum-Dietrich, 2011). When completing pre-service programs, teachers learn very little about laboratories, procedures, and outcomes. This study examines how hands-on field learning and teaching can better prepare teachers to become STEM advocates.

The effects of No Child Left Behind have trickled down to science, 53% of school districts surveyed, cut their science instructional time by 75 minutes per week (Marcum-Dietrich, 2011). With students spending less time on science, it also cuts down on the time for authentic and active outdoor exploration.

This decrease in science time, requires meaningful science exploration for the little time that is remaining (Marcum-Dietrich, 2011). As teachers become more confident in teaching science, the student's ability to learn through exploration, manipulation, questioning and searching answers will also increase (Marcum-Dietrich, 2011).

Teachers have a great influence over their students, and research suggest that negative comments by teachers can be more impactful than positive comments (Marcum-Dietrich, 2011). Teacher discomfort with science can be based on their lack of skills.

There has always been concern surrounding students not spending times outdoors as they once did (Marcum-Dietrich, 2011). A huge part of science in exploring the natural world around you, a lot of which takes place outdoors. Research suggest more than 70% of US students are likely to graduate high school without completing a course on Earth Science (Marcum-Dietrich, 2011). Even as teachers are being prepared in college, these courses are lecture style and do not require any outdoor exploration. It's going to be difficult to provide outdoor learning experiences to a generation that is growing up indoors (Marcum-Dietrich, 2011).

If we expect preservice teachers to use inquiry teaching and learning, they must experience it in their own undergraduate education (Marcum-Dietrich, 2011). This study suggests, undergraduate teachers participate in a four-course science sequence based on Earth systems and geoscience pedagogy and the role human beings play in the natural environment (Marcum-Dietrich, 2011). In addition, there should be a k-8 pre service course designed to integrate scientific content and pedagogical practice for new teachers to the profession.

Future science teachers need science content courses that model how to use outdoors as the basis for classroom instruction. This will require science instruction to move away from lecture-driven, cookbook lab style and move towards hands-on, collaborative, outdoor learning experiences (Marcum-Dietrich, 2011). Included in pre-service education should be the opportunity for students to develop lessons and teach these lessons to young children, and revise and improve their teaching (Marcum-Dietrich, 2011). This will greatly help undergraduate teachers obtain the skills necessary to improve the quality of science education for elementary students.

In conclusion, a large part of science teaching involves the teacher being comfortable with the content (Marcum-Dietrich, 2011). Preservice teachers could benefit from more in-depth science courses being taught at the undergraduate level (Marcum-Dietrich, 2011). By increasing teachers content knowledge, it will also increase their confidence in teaching hands-on and outdoor learning to its students (Marcum-Dietrich, 2011).

Inquiry is another foundational pedagogical topic. It is perceived by teachers that school science and the work that scientist conduct are to vastly different things. One way to bridge this gap, is for teachers to become well versed in inquiry (Blanchard, 2007). Professional development can help teachers understand inquiry and how to implement it in their classrooms.

Marine Ecology for Teachers Program did a RET study. One belief from the study is that teachers who experience the practice of science and use it in the ‘real world’ can better communicate concepts to their students (Blanchard, 2007). Teachers beliefs about science and inquiry tend to influence how they teach, Kegan talks about changing behavior depends on our feelings, beliefs and values, and our consciousness (Blanchard,

2007). Additionally, when teachers select to change, these changes are lasting. As teachers become more reflective in their work, the more change occurs.

Student discourse and questioning is at the cornerstone of science teaching. As students have the ability to ask questions and engage in discourse they are practicing 'real world' science skills (Blanchard, 2007). The student's ability to generate comments and questions without much intervention of the teacher helps in promoting inquiry. A teacher learning the skill of distributed authority, quietness, and wait will increase student inquiry (Blanchard, 2007). Classroom questions can be created with the help of Bloom's taxonomy to provide insight into student thinking.

The goal of this study was to change teachers' conceptions and foster inquiry in the classroom (Blanchard, 2007). Participants included, four secondary teachers. The study began with teachers walking along the shore of the marsh and making observations which promoted a large number of questions.

Teachers went on to adapt lesson from their current content area to use the model of inquiry that they experienced (Blanchard, 2007). Teachers lessons were written alongside a program staff person to ensure inquiry and the appropriate levels were clear (Blanchard, 2007). Teachers would then test out their lessons, video record them, and fill out a questionnaire.

The study used a mixed methods approach to focus on teachers' understanding of classroom inquiry before and after the experiences (Blanchard, 2007). Overall, all teachers were able to become facilitators of the students learning. Teachers also reported a change in questioning that better supported the inquiry model.

In conclusion, the study met its goal of bridging teachers by engaging them in authentic scientific inquiry. These teachers gained an understanding of inquiry through a

direct research experience (Blanchard, 2007). Engaging teachers in multiple forms of inquiry and different models played a role in their ability to deconstruct inquiry into essential parts. The professional development was successful for teachers because for the ability to explore, reflect upon, and revise their concepts of teaching and learning (Blanchard, 2007).

Determining what should be taught in science is an international concern. The next study explored what should be taught in science, while bringing awareness to the issues and problems that are raised while teaching science. 11 science teachers from the UK who teach elementary, junior high and high school were participants in the study. Nine themes emerged from the study of what's important for students to learn in science: Scientific methods and critical testing, Science and certainty, diversity of scientific thinking, hypothesis and prediction, historical development of scientific knowledge, creativity, Science and questioning, analysis and interpretation of data, cooperation and collaboration in the development of scientific knowledge (Bartholomew, 2003).

Science teacher's confidence and ability to teach about science is a premise has held back much of the work in this area (Bartholomew, 2003). Furthermore, constraints of curriculum, classroom management, lack of time and student engagement also play a role. Science becomes secondary to other subjects that dominate classroom life (Bartholomew, 2003).

First teachers were able to see good practices of effective teaching within the nine domains. Teachers worked in age specific groups (based on their students) in order to share, develop, and adapt the given materials to their own ideas (Bartholomew, 2003). These ideas and lessons would be implemented during the school year. Each teacher received three visits from researchers to observe teacher to student and student to student

interaction during the lessons. Two of the three visits were video recorded, and teachers kept a diary of planning and reflecting while implementing the lessons.

Results from the study revealed various levels of teacher confidence. First, a teachers' understanding of science will determine if they are dispensing knowledge or equipping their students in open discussions (Bartholomew, 2003). These open discussions allow students ideas to be aired, and students are more likely to see learning objectives and understand them. In conclusion, as teachers develop lessons, they should be engaging and should help students understand the nature of science.

To continue improving science education, the Next Generation Science Standards (NGSS) were created. Student engagement and an emphasis on studying engineering should be integrated throughout teaching and learning process (Wilson, 2013). Professional development creators should take into account the effective characteristics of professional development and challenges teacher deal with in the classroom.

There are five general characteristics of effective professional development; Focusing on specific content, Engaging teachers in active learning, Enabling the collective participation of teachers, coherence, sufficient duration. Additionally, researchers have five additional factors; Activities are close to practice, Participants physical and psychological comfort is taken into account, Teachers are immersed in inquiry experiences and able to witness models of inquiry, Curriculum materials are educative for teachers and students, Teachers receive direct instruction in specified materials, Principal support is emphasized (Wilson, 2013).

There are some challenges in science professional development. First, there is a looming challenge of trying to prepare teachers to teach NGSS and meet the needs of English Language Learners, while harnessing new communication technologies (Wilson,

2013). This will require considerable investment of resources and development of instructional materials to support teachers (Wilson, 2013). Professional development that integrates learning science and literacy through inquiry-based intervention can help with literacy and ELLs (Wilson, 2013).

In conclusion, teaching science is about the comfort and confidence of the teacher. Preservice programs can aid in teachers feeling more confident in their content knowledge (Marcum-Dietrich, 2011). Additionally, ongoing professional development can serve as a bridge once teachers enter the classroom.

**General preschool and the teaching of science**

Research is being done to close gaps in students from urban environments (Piasta, 2012). This research includes identifying strategies that help develop children academically, socially, emotionally and behaviorally in preschool. Children from economically disadvantaged backgrounds show gaps in language and communication skills, specifically vocabulary and discourse (Piasta, 2012). This study focuses on providing professional development to 25 preschool teachers. These teachers will learn specific responsivity strategies to be used within social exchanges in the classroom environment (Piasta, 2012).

Research suggest, that children's language is determined by the quality and quantity of language and being used in social settings (Piasta, 2012). Which means, the environment and classroom language used in preschool can be a determinant of language productivity. High quality language for at-risk students is essential in order to keep them on track (Piasta, 2012). However, current studies show that economically disadvantaged students are receiving low quality language learning which continues to contribute to the learning gaps (Piasta, 2012).

One way to improve this low-quality language, is by helping teachers understand conversational responsiveness (Piasta, 2012). It is the ability to respond verbally or nonverbally to a communication partner and maintain topics for successive turns (Piasta, 2012). Teachers can achieve this by encouraging student's participation in discourse (Piasta, 2012). More specifically, using communication such as, open ended questions, and a slower pace of speaking can promote student participation in conversations. Teachers can provide open-ended question, and a slow pace of speaking (Piasta, 2012).

Effective professional development provides educators with rationale supporting the relevance and importance of new or modified practices (Piasta, 2012). Furthermore, professional development should include opportunities for practice, self-reflection, coaching, and feedback.

There were many findings as a result of this study. There was low use of conversational responsivity strategies, for example: using a slow pace and asking open ended questions. There was extremely low use of labeling, recasts/expansions, explanation and modeling of decontextualized language (Piasta, 2012). Even after professional development was administered, the usage was still low. Teachers were more likely to use conversational responsivity strategies in small group interactions (Piasta, 2012). This finding helped to show that professional development has the potential to increase the use of communication strategies. Teachers that used more linguistically productive language produced students that used more complex utterances (Piasta, 2012). Researchers also suggested allowing students more dramatic play time and consistent on-site coaching can positively affect conversational responsivity (Piasta, 2012). In conclusion, this study highlights the needs of urban students as it relates to language development.

This next study focuses on how early childhood teachers are undervalued, underserved and underpaid. At the same time, early childhood educators are looked to provide a solid educational foundation for students as they enter grade school (Baker, 2017). It's expected that early childhood teachers foster learning through integrating play-based approaches, fostering relationships and socioemotional learning

While creating professional development for early childhood educators', it's important that the training is congruent with the teacher's beliefs and teaching style

(Baker, 2017). Teachers who do not see the value in fostering certain skills maybe less likely to modify their instructional practices. Furthermore, the training should consist of research practices that fit with teachers' attitudes, experiences and beliefs within the context of where they work (Baker, 2017).

The current study was done in Boston Public Schools over a 5-week period with 18 kindergarten teachers. It focused on teachers attitudes about professional development and how contextual factors within and beyond the classroom impact curriculum implementation (Baker, 2017). The study consisted of surveys, classroom visits, and interviews.

Finding from the study highlight that during professional development, the teachers found it more useful to view exemplar videos of the curriculum being implemented instead of spending time planning and going over PowerPoints (Baker, 2017). After completing the professional development, teachers desire time outside of training to process and comb through the information before the next professional development session (Baker, 2017). In conclusion, teachers found it useful and necessary to collaborate with other teachers while trying to implement the new curriculum (Baker, 2017).

Early introduction to STEM concepts can create a solid foundation for young children (Brenneman, 2019). Additionally, rich STEM experiences can positively affect dual language learners (Brenneman, 2019). The article identifies the elements of effective professional development that enable and empower educators. A child's math skills as they enter kindergarten can be a predictor for math and reading skills as they move through grade school. It's also important for the math lesson to be of high quality. Science also experiences less classroom time and lower-level rigor (Brenneman, 2019).

One way to improve the outcome for students, is to provide support for teachers so they are empowered to provide high quality STEM education to students (Brenneman, 2019). The purpose of this study, is to discover effective pedagogy for teaching STEM learners, including dual language learners. The first model, SciMath-DLL has three components. First, workshops that would deliver and support content learning, developing teaching strategies in small groups-using hands-on activities (Brenneman, 2019). The second component of the model is a reflective coaching cycle. This cycle would provide individualized coaching, goal-setting, and feedback (Brenneman, 2019). Third, professional learning communities would bring together teachers and coaches together in small groups to discuss a common problem of practice (Brenneman, 2019).

SciMath-DLL supported district coaches and teachers throughout the project. During the reflective coaching cycle, the ScieMath-DLL coaches ensured that the coaching was aligned with best practices and allowed district coaches to gradually take the lead in reflective coaching conversations (Brenneman, 2019).

Building teacher's content knowledge in math and science were completed during workshops and were aligned to cover national state math and science standards for early childhood teachers (Brenneman, 2019). As a result, workshop activities were created to link familiar preschool activities to illustrate how math and science can be integrated. Additionally, science and math can help improve language and literacy (Brenneman, 2019). Teachers can promote rich vocabulary and asking students to communicate their reasoning. SciMath-DLL modeled how teachers can use math and science content for students to think, talk, read, and write about (Brenneman, 2019).

High quality professional development for teachers should present information, facilitate discussions and interactions at multiple levels- large group, small group, and

individual (Brenneman, 2019). Similar to younger students, adults also benefit from information being presented in several formats. Additionally, best practices for adult professional development will provide teachers with time to practice, be observed, and receive feedback. During the observation process, teachers were recorded in order to help teachers better reflect objectively (Brenneman, 2019). Results from the study were 81% of teachers experienced a change in their science/and or math teaching. 95% of the teachers rated the program as beneficial.

In conclusion, there are ten best practices of professional development gained from this study are: 1. Educators and administrators are part of the ongoing design, 2. Includes supporting coaches, 3. Builds teachers content knowledge, 4. Attends to teachers' attitudes and beliefs, 5. Engages with teachers at multiple levels (large group, small group, and one-on-one), 6. Is connected to classroom practice, 7. Involves educators reflecting on practice, with feedback, 8. Creates a community of practice, 9. Is sustained and long term, 10 is individualized (Brenneman, 2019).

In order to meet educational standards, most states require early childhood teachers to participate in professional development. However, the early childhood workforce is insufficient in financial support, lacks understanding of early childhood teaching, and it's hard to find quality and meaningful professional development (Han, 2012). This study explores a professional development approach that will promote young children's peer social competence. In effort, to build on current research that suggests high quality preschool experiences offer long lasting positive outcomes for children (Han, 2012). One-shot professional development or sit and get workshops are often ineffective (Han, 2012). These models do not help teachers address the dilemmas that are present during implementation. Professional development opportunities that include mentoring,

peer coaching, and collaboration that focus on teaching and allow for reflection are more impactful (Han, 2012).

Peer social competence is how a child solves challenges, initiates and sustains interactions, resolves conflicts, and builds friendships with peers (Han, 2012). These interactions are a large part of school readiness and can influence a child's adjustment to schooling later in life (Han, 2012). A teacher who understands the social needs and knows how to provide appropriate support can enhance each student's growth in peer social competence.

Teacher's beliefs are one of the most powerful determinants of their actions and practices used in the classroom (Han, 2012). Strong teacher beliefs can help teachers overcome environmental obstacles (Han, 2012). Teacher education or preparation programs should also be soundly grounded on shifting their foundational beliefs. This study seeks to understand the impact of professional development on early childhood teachers' beliefs and use of instructional strategies to promote children's peer social competence (Han, 2012).

The results of the study illustrated the need for quick problem-solving tips, rather than systematic frameworks (Han, 2012). Teachers also struggled in communicating with parents especially around discipline concerns. Lastly, teachers want additional help in connecting peer social competence instructions with the appropriate childhood developmental standards (Han, 2012).

In conclusion, teachers desire culturally responsive instruction and standards that support their instructional decisions. Professional development should meet the needs of teachers who work with diverse young children and their families, it should be culturally

responsive. Ongoing professional development should provide teachers with knowledge, confidence, and new strategies.

Parental involvement is a huge part of student success (Brown, 2009). This study aims to illustrate how student success extends beyond the classroom. The quality of relationships that students experience with their parents set the stage beyond preschool (Brown, 2009). As a result, professional development must extend beyond the classroom. This study focuses on providing professional development for the teachers in order to promote parent-child engagement. The purpose of the study is to promote confidence and competence of parents as they support their children.

The Getting Ready project is a federally funded school readiness project. This initiative guides teachers/ practitioners to support parents from birth to 5 years (Brown, 2009). The practitioners help in guiding parents to engage in warm and responsive interactions, support children's autonomy, participate in children's learning. Additionally, practitioners' will support parents in collaborative interactions to support children's learning and development (Brown, 2009).

As part of the research, practitioners or teachers started with a 2-day institute to introduce triadic and collaborative planning. Next, practitioners were coached twice a month during home visits. The coaching sessions were with the intent of moving practitioners to more of a triadic/collaborative strategy. Additionally, one session a month was individualized and one session a month was in a group format with all participants.

There were three major themes within the study; Self-perceived changes in confidence and competence in enhancing parental engagement, Relationships as supports for change, Time, pressure and paperwork woes (Brown, 2009). One teacher believed the program helped her feel more confident and her professional practices have evolved

(Brown, 2009). It isn't just about looking at the teacher, child or parent, it's about looking at all three. Teachers experienced an improvement in communication between the them and the parent which improves the parent engagement (Brown, 2009). Teachers employed empathy of weighing the parent's point of view, while also taking a step back and giving more responsibility to the parent. Practitioners realized as they took a step back to observe, they were able to coach the parents better (Brown, 2009).

In conclusion, the practitioners experienced growth from coaching sessions with the researchers. They would be recorded during their interactions with parents. This allowed the practitioners' to see themselves in action and provide self-critiques with the coach (Brown, 2009). Open communication between the coaches and practitioners helped encourage open communication between the practitioners and parents (Brown, 2009).

**Equity in Science teaching**

Science and STEM require hands-on lab materials, which cost money. For schools that are low-income, often these resources and materials are not readily available which can impact student success (Bianchini, 2015). This section explores the research available on equity in science classrooms. Reforming science and math education continue to be a long process (Bianchini, 2015). Part of reforming this process is through professional development that allows math and science teachers to practice. Professional development requires teachers to reflect inward about their ideologies and pedagogy in order to captivate all students by changing the curriculum and instructional practices (Bianchini, 2015).

Teaching for Equity and Mathematics and Science Education (TEMSE) at the university of Southern California, conducted the study from 2003 to 2005.The aim of this study is to understand and address equity issues in the classroom as it relates to math and science education.

This study views equity as being three dimensional, teachers and their teaching, students and their learning, and home and community contexts (Bianchini, 2015). To provide equitable math and science skills for all students, teachers must first examine their own practice. As change agents, teachers should foster the ability to learn as well as teach in their classrooms to better empower their students (Bianchini, 2015). Teachers should see themselves as guides and facilitators who implement strategies for literacy and core concepts for students fluent in English and English language learners (ELLs) (Bianchini, 2015). Eventually, teachers should move beyond guides who help students navigate on their own by critiquing and challenging students (Bianchini, 2015).

When it comes to students, real-world connections can be helpful, but must be attainable based on students' various backgrounds (Bianchini, 2015). The teacher should implement the students' culture into curriculum and instructional decisions, in doing so, students are more likely to retain information and enjoy math and science (Bianchini, 2015). Additionally, teachers must establish relationships and rapport with students while utilizing these bonds to transform the classroom (Bianchini, 2015).

Last, equity in the math and science classroom must identify, celebrate, and use diverse resources that are present in students' home and community to transform curriculum and instruction (Bianchini, 2015). Teachers can examine local knowledges and practices to pull into the curriculum. Additionally, allowing students time to explore outside of their school and into the community and can improve the lives of students and the community they live in (Bianchini, 2015).

Teacher talk can be instrumental in student math and science success. This talk must include the students and their daily movement between academic language and their home language (Bianchini, 2015). Educators rely on Professional Learning Communities for shared discourse and learning (Bianchini, 2015). Teachers can show the students how to establish learning communities within their classroom. In this case, minimizing the teacher talk to help students learn from one another can be beneficial in math and science success. As the teacher monitors the learning communities within the classroom, it helps the teacher assess and reflect on their instruction therefore providing more equitable education (Bianchini, 2015).

The qualitative data that was used consisted of; seminars, individual interviews, and presentations of research projects conducted in the classroom along with a written

reflection. The research question asked, “How did teachers’ shared equity talk vary across these four strategies?” (Bianchini, 2015). The strategies consisted of: engagement in teacher research, reflection on personal experiences, modeling of reform-based instructional practices, and examination of school/state/national data on student course taking and achievement (Bianchini, 2015). In addition, TEMSE believed there are five features of effective professional development; focus on subject matter content and how students learn that content, provide opportunities for teachers to engage in active learning, sufficient duration, collective participation of teachers from the same school, and department; and is built from teacher participants’ existing knowledge and beliefs and aligned with school, district, and state policies (Bianchini, 2015).

First, teachers were asked to conduct research on their own practice, to allow them to learn from their teaching and teach from their learning (Bianchini, 2015). This included a research question, and a method to collect and analyze data. These findings were shared during state and international research conferences (Bianchini, 2015).

Secondly, teachers were asked to examine their own and others’ personal experiences with inequities in society and in science and mathematics education. This reflection called for examination of different forms of prejudice and discrimination and understanding, and school and classroom practices can mirror what’s taking place in society (Bianchini, 2015). In teaching diverse students, teachers must first be aware of their own identities and biases in order to develop a sense of empathy for students who are culturally or racially different from themselves (Bianchini, 2015).

Third, reform based instructional practices are effective in teaching science and mathematics to diverse students. Furthermore, these practices support disciplinary content and language development for ELLs (Bianchini, 2015). Viewing science and

mathematics from a multicultural lens, helps connect school content to students' experiences, interest and community, which overall create a more in depth understanding of science and mathematics (Bianchini, 2015).

In conclusion, teachers were encouraged to examine school, state and national achievement data to identify patterns and examine how policies can affect students differently. Furthermore, this data helps inform teachers of their views and practices as it relates to equity (Bianchini, 2015).

Overall, this study found teachers' talk about equity to be the most challenging, whereas, school/state/national data had the most strengths (Bianchini, 2015). In fact, the data conversation helped elicit more conversation about equity. The study also found it difficult to engage teachers to participate in interrogating equity issues as it related to personal experiences. Teacher research strategy yielded a high percentage of equity conversation (Bianchini, 2015). During discussion about their own research or state research, it provided a platform to discuss their own practices or beliefs.

Teacher bias can limit effectiveness of the course and overall disadvantage the students who the teacher is being biased against (Killpack, 2016). Diversity in student population at the collegiate level has increased, and programs that seek to include minorities in STEM has also increased (Killpack, 2016). Unfortunately, diversity in faculty, leadership and institutional culture has not kept up with diversity changes (Killpack, 2016). Campuses must create a culture that welcomes and values student's cultural diversity. Inclusive and equitable teaching practices have a greater influence on STEM performance and confidence than the students background characteristics (Killpack, 2016). Latino students decrease 20% in natural science majors after their first year of college, and 40% for black students (Killpack, 2016).

There is a lack of resources available to inform and support faculty's diversity efforts in STEM classrooms (Killpack, 2016). Professional development in regard to diversity and inclusion is limited to learning styles. While learning styles are valuable knowledge, this conversation race, class, gender identity are huge influencers in the classroom and should be taught as well (Killpack, 2016).

There are three items teachers should be mindful of when teaching STEM courses. First, teachers should be aware of the privilege gap between themselves and their students (Killpack, 2016). Secondly, acknowledging and confronting implicit biases. Last, mitigating stereotypes in our classrooms (Killpack, 2016). Privilege can derive from demographic attributes. For example, if your family member earned a college degree or works in a STEM field, it is likely that you gained information about how to navigate academically or in your career (Killpack, 2016). Additionally, if you didn't have to work during semesters or summers, you were probably able to take part in research internships to grow your resume (Killpack, 2016). These are important factors to consider when designing our STEM courses.

In conclusion, meaningful faculty diversity training can lead to improvements in classroom climate and excellence in STEM (Killpack, 2016). Unconscious biases can lead to discriminatory thoughts and actions, such as, shifting evaluation criteria, position requirements during faculty search and hiring processes can result in inequalities (Killpack, 2016).

This next study examines how to groups of Canadian students are seeing discrepancies in test scores as a result of language barriers (Rivard, 2015). Minority Francophone schools and boards are small in comparison their English counterparts and do not benefit from the same economies of scale (Rivard, 2015). Teachers are also

affected by heavier workloads, more disparate, and typically encounter greater expectations from the community (Rivard, 2015). Additionally, these teachers work with multi grade classes with very limited resources and support. At home, many students begin school underprepared as they come from families who struggle in language as well (Rivard, 2015). Pedagogy should ensure that all students are able to learn both the concept and language of science despite the socio-political nature of language (Rivard, 2015). This study examines the impact of a professional development program for supporting secondary science teachers in minority language schools.

Science classrooms have potential for developing language skills, but teachers devote very little time to language of science, including reading and writing about science (Rivard, 2015). Additionally, teachers lack the knowledge of how to integrate language-based activities in their science teaching. The goal of the program is to transform participating teachers' knowledge and beliefs about the role of talking, reading and writing in content areas classrooms, as well as their practices while teaching secondary science (Rivard, 2015). The primary focus is to determine how minority Francophone teacher beliefs and practices changed as a result of a small-scale professional development program on language enhanced science instruction and the impact of these changes on learners (Rivard, 2015).

Results showed that teachers increased utilizing pre-read strategies to teach vocabulary and establishing goals for specific literacy tasks (Rivard, 2015). Additionally, teachers identified literacy tasks to use in the science classroom. Teachers reported that more students were interested and engaged with learning. Students reported using many strategies prior, during, and after reading texts (Rivard, 2015).

In conclusion, teachers believed the collaboration with colleagues and seeing strategies modeled were most helpful in creating success. Additionally, having a mentor who observed classroom instruction, collaboratively planned lessons, engaged in pre and post conference discussions with language integration in science all contributed to teacher success. Effective questioning, collaborative learning and differentiated instruction were also a result of the mentoring relationship (Rivard, 2015).

**STEAM**

STEAM is becoming a way to re-introduce art back into low socioeconomic schools. STEM has made great strides in providing equal resources to students and schools of low socioeconomic (Lilawati, 2018). It's contributed to closing the achievement gap, introducing students to STEM careers, and growing the number of girls that are interested in STEM and STEM careers (Lilawati, 2018). In recent years, STEAM has begun picking up traction, however many of the same low socioeconomic schools that are embracing STEM, are noticing a cut in their fine arts budget, doing away with art, theater, and music classes (Lilawati, 2018). STEAM is the integration of science, technology, engineering, math, and now art (Lilawati, 2018). This art integration has created more funding opportunities in the form of grants, but it's also increased student retention in the material they are learning (Lilawati, 2018).

This next study is exploring how STEAM integration can improve mastery of a concept. STEAM is an extension of STEM, through integrating art, it adds positive and rich element that can be applied to various forms (Lilawati, 2018). Art can be looked at as fine art, communication, theater, fashion, and even culture (Lilawati, 2018). For example, students can utilize drama to create or explain concepts in science. All of these various forms of art will help students embrace differences and become creative thinkers. For struggling learners, STEAM can help in better understanding harder concepts and how these concepts are applied in everyday life (Lilawati, 2018).

This study utilizes STEAM to teach the theme Water and Us to junior high school students (Lilawati, 2018). In this unit, science will be applied in explaining the phenomenon of water. Technology will be used in the measurement of rainfall. Engineering will be used as students design models to address pollution (Lilawati, 2018).

Art will be used to explain the phenomenon of water by including elements such as writing or drawing and bringing awareness to the importance of water. Lastly, mathematics will be necessary to measure rainfall and design a safe mask and goggles used during the dry season (Lilawati, 2018).

There was an increase in the average score on the posttest compared with the pretest. Learners were motivated and took the learning process seriously, because the topic related to their everyday lives (Lilawati, 2018).

Overall, STEAM approach can improve mastery of learners and provide an opportunity to explore and make connections between science, technology, engineering, art, and math (Aristantia, 2017). Student mastery in STEM creates learners that are more creative and engaged, and teachers who are able to enjoy the art of teaching (Lilawati, 2018).

Early childhood teacher's beliefs are important as it relates to STEAM education. This study examines preschool teachers attending a professional development conference (Faiza, 2017). STEAM has the ability to be powerful, create authentic learning opportunities, and can help engage students in challenging STEM skills needed for the workforce (Faiza, 2017). The study explores how early childhood preschool teachers conceptualize, understand, and value STEAM approaches to pedagogy, their abilities and dispositions towards STEAM (Faiza, 2017). Teachers understand the value in STEAM education and that the hands-on learning activities can draw on multiple content areas. However, teachers lack in the thorough explanation of what STEAM teaching looks like, how teachers engage in it, benefits and challenges in a real classroom implementation of STEAM (Faiza, 2017).

In the US, STEAM is still an emerging paradigm, especially among early childhood educators'. The purpose of STEAM is to encourage young learners on the process of creating new things, see familiar things in a new way, combine things in nontraditional ways, think independently, and unconventionally (Faiza, 2017). While STEM has been a focus for a long time, STEAM is looked to add artistic expression and encourage risk taking to meet challenges in new ways (Faiza, 2017).

Teachers beliefs and attitudes have a strong impact on their classroom effectiveness (Faiza, 2017). More specifically, teachers' beliefs about the strength of their own knowledge base and resources can aide or impede their ability to plan and execute complex lessons (Faiza, 2017). If teachers believe they have inadequate skills or low self-efficacy in a particular content area, they may be inclined to spend less time focusing on the concept in the classroom (Faiza, 2017).

The framework for the current study is known as STEAM Classroom Assessment of Learning Experiences (SCALE) model. This method suggest that well-executed STEAM learning experiences must draw on a set of desirable knowledge and pedagogy in order to achieve the learning outcomes (Faiza, 2017). The SCALE model includes instructional practices, assessment practices, and ways to support equitable participation across students with diverse abilities and interest (Faiza, 2017). The model was used to develop the 1-day professional development workshop, that focused on STEAM teaching in early childhood classrooms. Secondly, the model was used to develop survey items intended to capture aspects of teacher beliefs about STEAM teaching. Third, it guided the overarching understanding of STEAM teaching best practices that we used in interpreting the study data and its implications for practice in early childhood classrooms (Faiza, 2017).

The goal of the data is to understand the types of supports and challenges teachers face while implementing the STEAM approach (Faiza, 2017). The results of the survey illustrated that beliefs about effective STEAM education would vary based on age, professional training and teaching experience (Faiza, 2017). Younger teachers with fewer years of teaching experience supported testing specific skills versus application problems. Additionally, these teachers also believe each student should learn the same material.

The results from phase two illustrated that teachers still see STEAM as an isolated task instead of an integrated approach in all subjects (Faiza, 2017). Additionally, teachers focused on STEAM being fun and engaging and less about the content and processes. Teachers also believed STEAM activities require a large amount of time and behavior management (Faiza, 2017). In conclusion, teachers had a hard time moving past surface level understandings with just a one-day professional development session.

Art can play a vital role in student's engagement during science lessons. In this study, two activities are being compared from an artistic viewpoint and science viewpoint. It is believed that art in science classes can positively impact students' attitudes and perceptions of science (Jakobson, 2015).

An elementary classroom is conducting a science study on leaves from an art and science perspective. Dewey believes, art better develops the power of attention, the habit of observation, and seeing parts in relation to a whole (Jakobson, 2015). This elementary classroom will be the focus to examine how students can learn about science through art.

Students will do two sequential activities, observing and rubbing leaves for two different purposes in an elementary class (Jakobson, 2015). Magnifiers will be used during the science activity and crayons will be used during the art activity (Jakobson,

2015). Researchers will examine what children are afforded to learn conceptually in science about leaves and how it contributes to students' aesthetic experiences.

The study consisted of children 6-7 years of age and 14 participants present. Teachers were asked to plan a science lesson that included art. First, the students observed leaves with magnifiers and thereafter rubbed the leaves with crayons. The children worked in small groups for 40 minutes.

Students were expected to observe and describe the leaves using the magnifier. The teacher facilitated additional questions as the students were observing. This helped student's awareness of what to include in their observations. Additionally, students observed aesthetics things that they did or did not like about the leaves.

Next, students went on to create a picture of the leaves by rubbing leaves through a piece of paper, using crayon (Jakobson, 2015). Students were able to distinguish that leaves from different trees have different shapes and were recognized as different species (Jakobson, 2015). They were able to compare the leaves to a star. Students proceeded to teach each other how to continue the imprint activity. Furthermore, students were able to identify with three-dimensional shapes from the rubbing activity. Aesthetically, students would compare the beauty of a star to the beauty of the leaf.

The student's experiences differed with the science and art lesson, meaning the direction and purpose should be taken into consideration with each choice (Jakobson, 2015). Observing the leaves with magnifiers allowed students to observe microscopic qualities, including similarities and differences (Jakobson, 2015). Rubbing with crayons allowed students to observe comparisons between different kinds of leaves (Jakobson, 2015). Aesthetically students expressed less while using the magnifiers. However, the crayon activity created more imaginative imprints.

This study highlighted how art can be used to enhance the science content, further suggesting art can be a means for learning science (Jakobson, 2015). The leaves observed and rubbed were not just objects, but developed and became visible (Jakobson, 2015). Artistic and science activities should be selected by the teacher based on the desired outcomes.

The next study examines how STEAM can be utilized in early childhood classrooms through the librarian and art teacher. As a result of Barack Obama's 2009 initiative "Educate to Innovate" campaign, engineering became an emerging focus for all grade levels (DeJarnette, 2012). This qualitative study examined the impact of a year-long STEAM initiative implemented in a high needs K-2 school. Two teachers participated, researchers examined perceptions, self-efficacy, and dispositions of the teachers.

Young children between the ages of five and eight are at a prime age for learning STEAM content as their inquisitive and exploratory nature make for natural scientist (DeJarnette, 2012). They constantly question why things happen (DeJarnette, 2012). By exposing students to hands-on, interactive, problem-based activities will increase students' interest in STEM careers (DeJarnette, 2012). Currently, the United States is experiencing a lack of high school graduates entering STEM disciplines and careers. This is alarming, because STEM jobs are on the rise while the country is experiencing a shortage in STEM professionals (DeJarnette, 2012).

Teachers self-efficacy is defined as one's own proficiency on a task. This relates to how confident the teacher feels in their performance or competency relating to a specific task. (DeJarnette, 2012). There is a gap between early childhood educators' training in STEAM versus middle school and high school teachers. In the past,

engineering was not included in the early childhood curriculum. (DeJarnette, 2012). As a result, teachers are intimidated and exhibit negative dispositions and lack self-efficacy. (DeJarnette, 2012).

The study is based on Sociocultural Theory and the Constructivist Approach. Constructivism focuses on providing children experiences through authentic problems that reflect their environment, which allows them to take ownership of the task at hand (DeJarnette, 2012). The learners gain understanding through interaction with others and their environment. Through social interaction and reflection, children are able to develop cognition. Problem based learning models use constructivism that allows children to develop understanding through interaction with their environments (DeJarnette, 2012). As students work collaboratively with their peers, to solve a problem they learn from each other by doing the work. In this study, K-2 students will solve an engineering design challenge that includes STEAM. The approach used for the study was based on constructivism and sociocultural learning.

Two early childhood teachers in a high needs area was provided on-going support throughout their STEAM implementation. Teachers were provided professional development and in class support with the intent to build efficacy and positive dispositions towards STEAM while developing consistent and regular STEAM lessons for students in the future (DeJarnette, 2012). One female teacher was the school librarian, and the second male teacher was the art teacher. There were about 300 students involved in the study. This campus was high needs based on high poverty, weak employment, and limited parental education (DeJarnette, 2012).

Each STEM lesson began in the library with a read-a-loud story from the librarian. The literature was selected based on the specific problems that students could

solve as their challenge. Students were then separated into groups and would begin drafting a plan to solve the design challenge. The following week when children attended art class, they would begin the construction and testing phase of the design challenge. He reviewed the story, discussed their collaborative ideas and plans they generated, and provided the materials for them to construct, build, and test their designs with their small group (DeJarnette, 2012). The art component of STEM was infused through themes based on the grade level. Kindergarten students focused their art component on animals, first grade focused on fairytales, and second grade focused on architectural building designs. The engineering design process that was used consisted of Ask, Imagine, Plan, Create, and Improve.

Results highlighted that both teachers did not feel they possessed the knowledge or confidence to plan and implement STEAM activities into their curriculum (DeJarnette, 2012). Both teachers held a high belief that STEAM implementation was within their reach and planned to implement. The post-survey showed teachers increased their knowledge, skills, and disposition regarding STEAM curriculum (DeJarnette, 2012).

Students illustrated an improvement in their critical thinking skills. Both teachers saw a difference in the student's problem solving and collaborative efforts. The art teacher believed initially he was skeptical of students being able to work together without fighting and arguing (DeJarnette, 2012). From his previous experience within his high needs school, students had a history of not being able to work together. His perception of students being unable to work collaboratively went out the window (DeJarnette, 2012). The art teacher highlighted that students at all grade levels worked collaboratively together. Additionally, the art teacher believed that some students were so used to struggling and failure, and now they were experiencing success (DeJarnette, 2012). It

provided the students a sense of ownership and they enjoyed the feeling of being successful (DeJarnette, 2012). The principal noted growth in the art teacher, he became more open minded and there was a change in his disposition towards STEAM (DeJarnette, 2012). Additionally, the principal noted that it was evident that students were learning to collaborate and work together. "Collaboration is not something that this diverse group of students are well-versed in" (DeJarnette, 2012).

The field notes highlighted a change in teacher dispositions. Initially, teachers stuck very closely with the lesson plans given. The art teacher even relied heavily on the researcher to lead and model the lesson. As he gained confidence, he began taking the lead (DeJarnette, 2012). The librarian showed signs of increased self-efficacy as she began to partner more with the researchers in designing the lessons (DeJarnette, 2012). She was better able to present the design challenge, lead students through the beginning planning stages and providing instruction on STEAM content while making connections for children.

In conclusion, young children are often overlooked when it comes to STEM initiatives because the notion, they are too young. In fact, young children are at the perfect age to begin fostering STEAM projects because of their natural curiosity (DeJarnette, 2012). Allowing them to develop their designs within the setting of art class provides a STEAM opportunity. Collaboration and communication are part of the 21st century skills that these young students were able to master (DeJarnette, 2012). The study had a positive impact on teacher efficacy, confidence and disposition.

# Chapter III

## Case Study

The research method used was a case study. A case study is based on generating or discovering a theory for a process that all participants have experienced (Crestwell, 82). This theory helps to explain a practice and provide a framework for further research. As teachers experience on-going, self-reflective professional development, they grow as educators, and ultimately students learn more. The single instrumental case study approach focused on preschool teachers from a central Texas school district. This approach was used in order to highlight the importance of ongoing professional development for preschool teachers in order to increase their confidence and perceptions of professional development in the science classroom. The case study was bounded by time and location. The triangulation of data consists of qualitative and quantitative data. The teacher interviews, qualitative data, offers open ended responses for more detailed accounts. The questionnaire, quantitative data, offers a greater ability to measure attitude and perceptions of the teacher's opinions. Combined, in a mixed method, both pieces of data provide more detailed information utilized to answer the research question. Preschool teachers are more likely to utilize, retain, and engage their students in through using the STEMscopes curriculum, especially if ongoing professional development accompanies the curriculum. 51 teachers from a Central Texas School District participated in the original study. For this archival research, only 3 teachers were examined as part of the case study.

## Introduction to Research

The research question that was addressed is: 1) What are preschool teachers' perceptions about professional development in science content and pedagogy when using a novel approach? The targeted population included 3 preschool teachers. There were two types of data instruments collected, teacher interviews, Preschool Teachers Attitudes and Beliefs towards Science Questionnaire. Utilizing a case study approach was ideal for this archival research study. STEMscopes Early Explorer archival data, aided in examining how to make professional development more meaningful. The data provided themes and highlighted teachers' needs pertaining to ongoing professional development.

## Participants

A central Texas school district was asked to pilot a new preschool program, Early Explorer. The district agreed and asked all preschool teachers participated. Out of all 51 teachers, a small amount was selected for more of a qualitative study. The convivence sample of teachers was selected based on their experience in teaching, the demographics of their students (low SES) and the teachers' willingness to participate. From the archival data, the sample population consisted of 3 teachers whom make up the case study.

Jennifer Brown, female, between the age of 25-34, White, with 2 years teaching experience, not new to teaching science, university certified, and holds a master's degree.

Kim Edison, female, between the age of 45-54, White, with 9 years teaching experience, not new to teaching science, university certified, and holds a bachelors' degree.

Richard Smith, male, between the age of 45-54, Hispanic, with 4 years teaching experience, not new to teaching science, alternatively certified, and holds a bachelors' degree.

**Study Context**

The study took place in a central city in Texas. All participants were teachers from a central Texas school district. The data used in this case study is archival from a previous STEMScopes study that focused on teachers increasing their science time through using the Early Explorer curriculum. The data was ideal for connecting how teachers increased their science time based on a well-polished curriculum, but also the result of on-going professional development plan. Increasing teacher science time is a two-fold, a well-polished curriculum and ongoing professional development.

The original study was conducted with 51 preschool teachers, across 51 classes and 16 campuses. There were about 1,140 students who participated. Of these numbers, 3 teachers were used for the qualitative case study. The records review analysis was comprised of teacher interviews, and Preschool Teachers Attitudes and Beliefs towards Science Questionnaire. There were two rounds of in-depth interviews, in the fall and spring. After completing two professional development sessions, completing modules within the curriculum, and having their fall teacher interview, teachers filled out the PTABS Questionnaire.

The initial study aimed to solve the problem of preschool teachers spending more instruction time on science. As a result, the digital resource was created that encompasses STEAM stations that teachers integrated in their core content areas. The study proved to be successful as teachers increased their science time by 34 minutes per day for a total of 36 minutes of science instruction. This pilot study contained many different variables that

contributed to the success of the program, one being professional development. Utilizing archival research allows for a more in-depth analysis of the research. It's important to highlight the overall success of the initial pilot, but to dig deeper in understanding the variables that contributed to the program's success, so it can be duplicated in other districts.

### Timetable

The timetable for this research study was one year in length. Before the school year began, teachers went through a 6-hour implementation training to begin using the product. Following the first training would be three more professional development sessions, two interviews and the PTABS Questionnaire.

### Data Collection

Teacher interviews were conducted via phone, once in the fall and once in the spring. The questionnaire was conducted in the fall after two professional development sessions. Both instruments were used to understand teachers attitudes and perceptions of STEM in the classroom. All data instruments were used to identify themes to aid in answering the research question.

### Interviews

Teacher interviews were done once in the fall and once in the spring. Each interview took about 30 minutes. The first seven questions asked about anticipated barriers, initial impression of the curriculum, complexity and rigor of the content, and if the training provide enough scaffolding techniques for the teacher to adequately teach the curriculum. The second part of the first interview asked specific questions about the four

components of the online curriculum (Ramp Up, Round Up, Wrap Up, Big Books and materials).

In the spring teachers had another 30-minute interview that focused on the four components within the curriculum. More specifically, the questions focused on usage of stations, utilization of wrap up activities, experiences with long term centers, and general questions about favorite and least favorite modules. The interview process consisted of the lead researcher contacting the teacher and asking them for about 30 minutes of their time to illicit feedback about the program and usage. The interview was conducted in the fall and spring, see appendix A for questions.

**PTABS**

The Preschool Teacher Attitudes and Beliefs towards Science Questionnaire was part of the study in order to gain insight into teacher attitudes and beliefs about science. The questionnaire included 35 questions about teachers attitudes and beliefs about science. The questionnaire used a Likert scale that asked teachers to select from Strongly Disagree, Mildly Disagree, Neutral, Mildly Agree, Strongly Agree. The questions gathered information about teachers comfort with teaching science content, if time was a hinderance in teaching science, if they had enough materials to teach science, and if they allowed students questions and natural inquiry to guide their lessons. This questionnaire was completed in the fall after teachers completed two professional trainings and began using the curriculum in the classroom. Teachers completed the survey digitally. The interview protocol is in the appendix B.

**Procedures**

In the fall, teachers took their first professional development course. The course highlighted how to properly use the digital curriculum. Such as, where to find background knowledge, standards information, materials, lessons, parent letters, and teacher set-up videos. Training also encompassed appropriate pedagogy so teachers could better understand inquiry and constructivism. Teachers learned about cooperative learning for student centered instruction, stations for exploration and investigations, and lastly student questioning for understanding. This helped teachers with classroom management, job and role designations, establishing centers and how to use the materials. At the end of each training, teachers filled out a survey on the effectiveness of the workshop.

A second training was conducted in October to explore student-teacher relationships for student-centered learning, and how to involve the family and community in science education. This training highlighted parental involvement activities and parent letters to support the content taught during science. Teachers filled out a second survey discussing the benefits of training.

Then, in December, a teacher interview was conducted to gather feedback on the digital curriculum, implementation of pedagogy strategies, and teachers' support needed for the next training.

In January, after the winter break, teachers completed another professional development workshop. This training served as a review of the curriculum and encompassed more modeling for teachers to better understand what the lessons should look like in the classroom. Additionally, the training focused on vocabulary, literacy, and how teachers can embed these practices throughout the curriculum.

The last professional development session took place in March and covered quality questioning to increase rigor and building capacity in teachers. This session taught teachers how to differentiate and raise their question levels based on student responses. In building teacher capacity, the training highlighted how to support teachers and bridge the gap between professional development and classroom practices.

In May, the second teacher interview took place to gather feedback on vocabulary implementation, questioning strategies used, and further improvements to the program and professional development. Overall, teachers received 30 hours of professional development throughout the school year on STEMscopes Early Explorer.

## Data Analysis

| **Research Question** | **Data Collection** | **Data Analysis** |
|---|---|---|
| What are preschool teachers' perceptions about professional development in science content and pedagogy when using a novel approach? | Teacher Interviews | Coding and Thematic Analysis |
| | PTABS Questionnaire | Document Analysis |

**Coding**

The interviews and survey data were coded using the coding software, NVivo. This software creates the process of gathering related material into a node. Through node identification, themes and patterns emerge to highlight important teacher information to utilize in the findings. First, open coding method was used to examine the teacher interviews and surveys. Then, the process of comparing and analyzing the data helped to create nodes of curriculum components and professional development components for a more inductive approach. This process allowed themes and patterns to naturally emerge. The curriculum components included any information about the usage of the digital resource, items teachers liked or items that could be improved. The professional development category contained teacher perceptions, training desires, and attitudes and beliefs about science professional development.

Teacher interviews were aggregated based on the curriculum, teacher perceptions and training desires. Teacher attitudes and beliefs were categorized based on content the teachers agreed or disagreed with. The sample size consisted of three teachers, and the interviews were conducted one-on-one, via phone.

In conclusion, the archival data is from the Early Explorer implementation study that looked to increase the science instruction time in the classroom. The research question being examined highlights teacher's perceptions and attitudes about science professional development as it relates to pedagogy and content.

# Chapter IV

## Findings

The research question asks, what are preschool teachers' perceptions about professional development in science content and pedagogy when using a novel approach? The initial study was conducted with 51 preschool teachers, across 51 classes and 16 campuses. There were about 1,140 students who participated. The records review analysis was comprised of teacher interviews, observations and lesson logs. Each teacher was required to fill out a lesson log, which included a checklist of the activities and materials that teachers used as well as open-ended responses for more feedback. There were two rounds of in-depth interviews and observations. All of this information was used in helping teachers improve their pedagogy, which overall would help teachers in effectively using the curriculum. In this study, STEMScopes evaluated if a preschool comprehensive curriculum would increase the amount of time teachers taught science.

Before the implementation, teachers would spend 2 minutes on science a day. Whereas after the study, teachers spent 36 minutes per day on science. The increase in time was due to the teacher's confidence and understanding of the curriculum, which was a direct result of the pedagogy training. It was also noted that during observations, there was an increase in the amount of science vocabulary students were using. As a result, STEMscopes curriculum increased science instructional time.

The interviews and questionnaire data was used in the current study that examined teachers perceptions and attitudes about professional development as it relates to science and pedagogy. Three teachers were used in this case study. The data was analyzed using

NVivo to examine  teacher interviews and a questionnaire. The findings and highlights are discussed in this chapter.

## Qualitative Results

### *Fall Phone Interviews*

There are many positives of the curriculum and professional development that teachers shared in their phone interviews. Teachers enjoyed the centers, mostly the variety, ease of setup and student engagement. The stations allowed teachers to integrate math, art and literacy. The teacher is able to assign jobs/roles to the students which creates student ownership and incorporates constructivism. Additionally, the curriculum provides parent engagement through an introductory letter and study review sheet for each unit.

Teachers set time aside every day to focus on STEM which aided in increasing the science instruction time. Additionally, working together in teams with other teachers to gather lesson plans and materials offered the teachers more support. During the training, teachers were shown how to create a binder that included quality questions to use during the lessons. This binder served as a quick resource for teachers to formatively assess the students.

There are also some improvements teachers suggested. The material set up is time consuming. Teachers also have a lot of printing that is required outside of material set up and this is overwhelming. Additionally, teachers desire more collaboration between campuses and during the trainings. Student modeling for this age group is heavily required and that has taken up a lot of the instructional time. Additionally, there are still some behavior issues and students learning routines.

Teachers desire more direct instruction on how to implement the curriculum and assistance in lesson planning. Teachers would like more training that is geared towards helping them better understand science content. Additionally, they desire time during training to prepare all the materials, stations, and plan with other teachers.

***Spring Phone Interviews***

There are many positives of the curriculum and professional development that teachers shared in their phone interview. The program covers the big ideas of what preschool students should know and is appropriate for their age level. Teachers are increasing their science time by 34 minutes per day. STEMscopes is great way to introduce students to major science concepts. The parent letter resulted in students asking more in-depth questions when they came back to school. Teachers enjoy the amount of literacy and math integration. The training on literacy and vocabulary was very helpful. It taught them how to take literacy and include it in Science. Teachers would like the literacy components in the curriculum to be leveled.

Teachers felt more confident after having a refresher training on the digital resource. Additionally, they enjoyed being able to work with their team and plan out the next lessons they are going to cover. The professional development sequence offered teachers on-going support and the ability to make adjustments. Each professional development session was created based on input from the previous session, which allowed teachers to feel heard and like their needs were being met. Teachers enjoyed seeing questioning strategies modeled for them, it provided them with an example to use with their students. Additionally, teachers believed the questioning strategies were applicable to their teaching and could be used immediately. Teachers felt most uncomfortable with questioning, so they were very appreciative that this was a

component of the professional development session. Overall, teachers still desire more communication and collaboration with other teachers.

## Quantitative Results

### *PTABS Questionnaire*

Quantitative results from the Preschool Teacher Attitudes and Beliefs towards Science Questionnaire are highlighted in this section. All teachers agreed that; preschool science activities help foster children's interest and engagement in science in later grades. Teachers believe more science should be taught in early childhood classrooms, and they want students to be able to freely explore science in the classroom.

Experimenting with hands-on activities is how students learn best, and all teachers felt comfortable doing science activities in their classroom. Science related activities help improve preschoolers' approaches to learning and it helps improve preschoolers math and language skills.

Teachers made an effort to include science throughout the week, as they believe all students were curious about scientific concepts and phenomena. Two of the three teachers believe there is enough time in the day to teach science, and that science related activities can help students with social skills.

## STEAM

The integration of art has increased student retention, creativity and engagement (Lilawati, 2018). This integration allows learning and teaching to be more enjoyable and impactful. As students begin to enjoy what they are learning, it's reflective in their

behavior. Low socioeconomic schools are introducing arts as a way to improve student behavior (DeJarnnette, 2012).

Art is changing teachers' beliefs as student behavior becomes more manageable. The ability to manage students, creates a more fulfilling work environment for teachers. Science content can be enhanced through art which can improve student's depth of content knowledge (Jakobson, 2015).

Students' attitudes and perceptions can also be improved through the use of combining art and science (Faiza, 2017). Additionally, students are more likely to take risk in art class which can have a positive effect in science (Faiza, 2017). As teachers begin creating STEAM lessons, it's important that the learning experiences draw desirable knowledge and pedagogy for desired results (Faiza, 2017).

**Jennifer Brown quotes**

Teachers believe science activities improve preschooler's math and language arts skills. "The curriculum contains multiple opportunities for literacy, math and arts."

**Kim Edison quotes**

The curriculum contains multiple opportunities for literacy, math and arts. "More than a supplementary STEM curriculum - you have the literacy, art, creativity."

**Richard Smith quotes**

Additionally, teachers believe the exposure and opportunities to explore is the most valuable to preschool students. "It's all about giving them that exposure and the opportunities to explore and become scientists. It's not just about weighing things and drawing on a piece of paper but actually engaging them in different activities to help them to expand their science knowledge."

In conclusion, teachers were able to empower their students through the use of STEAM. Teachers belief that their preschool students were capable and could be successful attributed to student success. This shift in teacher belief and confidence will aid in student belief and confidence.

**Teaching Science**

Teacher comfort in teaching science is often a reflection of their experience as a student in K-12. Meaning, if a teacher had a negative experience in grade school with science they are less likely to believe they are capable of teaching science. This belief can influence how much science is taught in the teacher's classroom (Ejiwale, 2013). Teachers with lower efficacy in science tend to hold a greater number of misconceptions about fundamental concepts, therefore decreasing their belief (Ejiwale, 2013).

Professional development can bridge the gap in teacher confidence, efficacy, and content knowledge. In teaching science, professional development should include opportunities for practice, self-reflection, coaching and feedback (Piasta, 2012). Teachers much like their students desire to be engaged in active learning. Additionally, teachers desire to witness models of inquiry, and have a curriculum that includes materials for teachers and students (Wilson, 2013).

Another way to bridge the gap is to better prepare teachers during undergraduate education. Courses that provide future teachers with a model of outdoor learning, hands-on and collaboration will ensure success (Marcum-Dietrich, 2011). Undergraduate education should also teach inquiry and constructivism while helping future teachers create lessons utilizing pedagogy (Marcum-Dietrich, 2011).

Oftentimes, science become secondary to other subjects due to curriculum constraints, classroom management, lack of time and student engagement (Bartholomew,

2003). Professional development that can aid in teacher roadblocks in order to increase the science teaching in the classroom (Bartholomew, 2003).

Findings in the study revealed that all teachers believe there is enough time in the day to teach science and, prepping for science takes the same amount of time as any other subject area. Teachers believe they have enough content knowledge in order to teach the subject, and that science should be taught at an early age.

**Jennifer Brown quotes**

Fostering an interest in science will add to student's science interest in later schooling. "It's important to flow with your students and allow them to lead the lessons."

**Kim Edison quotes**

Teachers realize they can't do everything within the curriculum, for some creating balance is the key. "It's about finding the balance between incorporating STEM along with the other domains." Additionally, the curriculum utilizes the current structure of a preschool classroom by incorporating centers. "Strength of Early Explorer is that it is incorporated throughout the entire room, throughout the entire day – small group, whole group, centers."

**Richard Smith quotes**

Teachers are able to increase their student's retention of material covered through consistent reflection. "We repeat like the vocabulary words we repeat them almost every day, two or three times during the day, and also I ask them again of what they remember about this, or what happens if we use the chocolate outside, or we take and the popsicles, what happens to your hands, and so I start to asking them questions about the topics all the time we use them."

In conclusion, the purpose of STEMscopes is to create teacher confidence and comfort through the curriculum and professional development with the intent to increase science time in the classroom.

**Equity**

Providing equitable education to minorities or low socioeconomic communities have three dimensions: teachers, students and home/community environments (Biannchini, 2015). Teachers are at the center of the three dimensions as a guide or facilitator who help parents and students navigate through their challenges (Biannchini, 2015).

Language development is important as students learn to read and write about the science they are learning. Low socio-economic students often are underprepared as they also have families that struggle with language (Rivard, 2016). As a result, students come to school with limited language development and it is on the teacher to aid in development. Through utilizing pre-read strategies and creating specific literacy task, this can help students comprehend the science text (Rivard, 2016).

Teacher talk can play a vital role in language development for math and science subjects. Teachers can show students how to establish learning communities in the classroom, as a result the teacher becomes a facilitator and allows the science to take center stage (Biannchini, 2015).

Diversity plays a huge role in equitable education. Teachers in STEM classrooms should be mindful of their privilege gap in relation to their students (Killpack, 2016). By offering empathy first, teachers can create a safe space for their students.

Findings in the study revealed that teachers feel comfortable in having enough materials to teach science because the curriculum used common classroom items. All

teachers agreed that Science related activities help improve preschoolers' approach to learning, further illustrating the importance of inquiry.

**Jennifer Brown quotes**

"Experimenting with hands-on materials is how children learn best. I gathered ideas for hands-on based on what students ask, say, and do."

STEMscopes offers information and study tips to include the parents on the concept's students are learning in the classroom. The first letter introduces the content to the parent. The second letter is in preparation of the summative assessment and gives the parents a few review activities to do at home with the students. "I've heard the kids come back and telling me that they talked about the science content at home."

**Kim Edison quotes**

Resources on a campus and at home can be limiting for low socioeconomic schools. "Within using a digital resource to teach, it was important to have a tool that was flexible to print as well as digital."

**Richard Smith quotes**

Many children have not had formal schooling prior to preschool. It requires the teachers to constantly assess where the students are and go through it with them. "at the beginning of the year because most of them they didn't go to any kind of school before. We are working numbers one through five."

**Professional Development**

Professional development should aim to deepen understanding, transform beliefs and assumptions to create continuous actions that affect the practice (Hirsh, 2003). After professional development has ended, teachers desire effective mentorship and opportunities to observe and be observed (Anderson, 2006). Additionally, teachers want

to collaborate within schools and across the district. Collaboration allows teachers to share ideas in order to change their practices (Anderson, 2006). As teachers able to interact with other effective teachers, it will strengthen student capacity (Hirsh, 2003). Teachers are able to build their skills through discussion, and feedback.

Findings from the study revealed that, for many teachers, getting started is the hardest part and once they start true learning can begin. First, teachers desire the time to sit down with material, process it, and begin building lessons with the help of other teachers.

Collaboration was one of the biggest requests that teachers had. They desire to plan, share, and decrease the workload. Teachers enjoyed having a product that contained prewritten questions, materials needed, and a video to walk through set-up instructions.

**Jennifer Brown quotes**

As a result of training, teachers were able to take it slowly and also rest assured that any issues that came up could be addressed during the next training. “And so, I think just because it's hard when you're getting something new and especially with everything that we are doing. I've had to tell myself multiple times, it's just one day at a time.”

**Kim Edison quotes**

Reflection at the end of each module was important for one teacher in order to track everything from one year to the next. As a result of training and the curriculum, teachers were able to implement 30 minutes of science per day. “Probably 30-45 minutes per day (compared to 10 minutes last year). We’ve never had the science embedded into what we do.”

**Richard Smith quotes**

During professional development, teachers learned assigning jobs and roles to preschool students can create empowerment. “They help to clean up. We have people that they are in charge of checking all the tables at the end of the day.”

In conclusion, professional development can increase teachers’ content and pedagogy strategies. Through the qualitative data-phone interviews revealed that the parental engagement in the unit encouraged students to ask deeper questions when they returned to school. Teachers felt more comfortable with the curriculum after their second, refresher training. Teachers still desire more help with lesson planning, and modeling of questioning strategies.

The quantitative PTABS questionnaire revealed, more science should be taught in early childhood programs. Experiment’s is how students learn best, and science activities improve math and language skills. Most of all, professional development can offer continuous ongoing support. Based on the finding’s teachers desire more collaboration and feedback to continue improving.

# Chapter V

## Discussion of Findings

The findings are significant as they illustrate the importance of a highly effective curriculum, but it also highlights the importance of ongoing professional development. The teachers were successful because of the ongoing professional development. The professional development welcomed feedback from the teachers to ensure that each session was exactly what they needed. During the interviews, teachers were able to express their difficulties and pedagogical practices that were working.

### STEM

In the STEAM section, teachers were very pleased that math, literacy and art content areas are components of the curriculum. One teacher discussed the importance of exposure and the opportunities to explore and become scientist. In chapter 2, the importance of the teachers' beliefs was highly regarded, as it directly affects the mindset of students. Teachers view science as "more than weighing things and drawing on a piece of paper, the more they expand their science knowledge," said Brown.

### Teaching Science

Teaching science is about fostering an interest in science and allowing students to lead the lessons and teacher facilitates. Teaching science is about balancing and incorporating the lessons within other content areas. During training, teachers experienced STEM as fluid and was better able to use whole groups and small groups, doing STEM became a more attainable goal.

### Equity

Equitable education is about the three dimensions of teacher, student and parents.

STEMscopes is able to ensure that the resources are accessible to low socioeconomic campuses by being a print and digital resource. Additionally, STEMscopes builds in the parental inclusion components. Parents were able to have meaningful conversation with their students about what they were learning in class. “The digital curriculum was also able to meet students where they were, as many of them had not experienced formal schooling,” said Smith.

**Professional Development**

Professional development is the bridge between a digital curriculum and increased science instructional time. Professional development’s ability to adjust, be customizable, and provide practices for teachers to implement instantly increases its effectiveness. As teachers began using the curriculum, they felt supported in knowing there would be other professional development days that would carry them through the school year. “Teachers were able to learn vocabulary and questioning strategies that they could immediately use in the classroom,” said Edison. As a result, teachers increased the amount of time they spent on science.

**Collaboration**

It was surprising that teachers desired more collaboration. Throughout the teacher interviews, collaboration during and after trainings was a consistent theme. Teachers desire more support and input from their peers, which takes place through collaboration. While professional development creators offer the pedagogy and expertise in the field, teacher confidence is gained through collaboration.

**Parental Involvement**

In the literature review, one article referred to parental involvement as the third dimension. As preschoolers enter school, their level of knowledge becomes a reflection

of the parent's involvement at home. Teacher, Richard Smith, talked about how some of the students didn't have any prior schooling experience and they are working on numbers 1-5. The Early Explorer curriculum includes a parent letter that coaches the parents on the content and questions to ask their child. It is imperative, for parents to be included but also guided on how to support the child at home. Parents can include their child in cooking activities, grocery store shopping, anything that requires counting will aid in the student and teacher's success. The three dimensions require the parent and teacher to be intentional and flexible with integrating Science, Technology, Engineering, and Math at t home and school.

**Mixed Methods**

There were correlations between the quantitative data and qualitative data. In the interviews and questionnaire, teachers discussed how engaged their students were in the curriculum. Student engagement is important because the more engaged the student is, the more likely they will retain the information. Both sets of data also highlighted the importance of hands-on activities for exploration and overall interest in science. Lastly, the interviews and questionnaire illustrated that students can learn math and language skills through science. Teacher, Jennifer Brown, discussed the integration of math, language, and art while using the digital curriculum. The integration utilizes the engagement in science to support the concepts students are learning in math and language arts.

In conclusion, teachers experienced success with a digital resource because the professional development took into account all the practices teachers needed to be successful. Teachers perceptions, attitudes and beliefs can directly impact student success. Professional development helped in supporting teachers so their beliefs could

empower their students.

### Implications for practice

Professional development creators have an important job of growing teachers, as their growth can directly affect the lives of students. Which means, content creators must have effective research practices that align with the needs of the teachers and students. Teachers actually value professional development that speaks to their needs and understands the obstacles they are facing in the classroom. Preschool teachers face many hurdles in lack of funding, lack of content support, and lack of effective ongoing professional development.

In order for preschool teachers to be effective STEM teachers, they need professional development that grows with the needs of the teachers. There is also a need for more modeling during trainings in order for teachers to feel comfortable in teaching the new strategies back in the classroom. It is important that professional development creators are open to feedback and are able to create customizable sessions to meet the needs of every teacher. Ultimately, professional development must be ongoing with the intent of growing a teacher from one session to the next.

Curriculum companies such as STEMscopes could address teachers needs through creating professional development plans. This would help to ensure that teacher support continues throughout the year. These plans should include multiple professional development sessions throughout the year, content workshops during PLCs, and allow teacher collaboration.

### Suggestions for future research

Future research can help in supporting teachers desire for more vocabulary and questioning trainings at the preschool level. Currently, teachers do not receive an adequate amount of trainings that are research based involving vocabulary and questioning. They would like strategies and modeling to support the new practices being learned.

Future research can figure out how to help generalist teachers become stronger and more confident in science content. Teachers desire content workshops that transcends from one unit to the next. Research could offer methods or ways to deliver this content in an ongoing effective manner. Additionally, teachers desire to collaborate with other teachers in the field. As teachers' complete workshops, collaboration creates a comfortable space for them to discuss their challenges and thoughts. More research in collaboration and the benefits to teachers could be helpful.

Lastly, teachers desire more research into professional learning communities (PLCs) that bridge professional development teachings and how to use them back in the classroom. Professional learning communities could be the mini workshops that take place between formal workshops. During the PLCs teachers can reflect on current practices and determine their needs for upcoming training. Preschool research on bridging PLCs would create more support for the teacher.

### Summary

There appears to be a decline in the amount of time spent on STEM curriculum at the elementary level (Nadelson, 2013). This research study was able to address how to increase science in a preschool setting. The teachers that participated in this study,

received a comprehensive digital curriculum appropriate for their students. Additionally, they received ongoing professional development that would grow with them throughout the school year. It is necessary that districts go beyond just an initial training. With anything, as we learn a new skill, it requires multiple lessons and feedback for improvement. As a country, we will continue to face a decrease in STEM-ready students and careers if ongoing professional development is not considered a necessity. Teachers will continue to teach as they have been taught (Nadelson, 2013).

Based on the findings in the study, teachers truly have a need for collaboration. Professional Learning Communities have been implemented on campuses. But teachers desire to consistently work with other teachers throughout the district. They desire to plan, gather materials, and ultimately create a continuous support system with the teachers in the district.

Every week as I have the opportunity to work with teachers all across the nation, it's my personal mission to ensure they understand the pedagogy associated with implementing a STEM curriculum. As important as education is to my family, it's important that I help mold teachers who will continue educating the next generation.

Future research could highlight the growth of students on a campus with teachers who undergo continuous professional development. Additional research should examine the current PLC models that districts are using to determine their effectiveness and changes to be made in order to meet teacher's needs.

In conclusion, solving our nation's crisis of preparing children to become doctors and engineers begins in preschool. Many STEM curriculums are being developed, but it's important to evaluate the professional development that accompanies it. The Early Explorer study ensured teacher success through ongoing professional development.

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# Appendix A

Teacher Interview Protocol

Introduction:
*Thank you for taking the time to provide us with feedback. The interview should take approximately 30 minutes, though you can stop the interview at any time. I would like to record the interview, is that OK? I can turn the recorder off at any point if you would like.*

*I would like to ask you some questions about the Early Explorer curriculum:*

## Fall Questions

1. What immediate barriers have you experienced, or do you expect to experience upon implementation?
2. What additional support will teachers need to implement Early Explorer?
3. What are your initial impressions of the curriculum?
4. Is the curriculum fun for the students and something you have never seen before? Are there real-world connections/applications infused? If you improved it, what changes did you make?
5. Did you find the question prompts attached to every activity helpful? How did you implement them in your classroom instruction?
6. Is the module developmentally appropriate (i.e. level of rigor, vocabulary used, sentence complexity, etc.)? If you improved it, what changes did you make?
7. Was enough information and scaffolding provided for the teacher to feel confident to adequately implement the lesson?

Ramp Up:

8. Is the Ramp Up succinct, easy, and clear for the teacher on what/how to implement with the students? If you improved this Ramp Up, how did you?

Round Up:

9. How many and which of the Round Up Centers did you use in this module? Why?
10. Is the "Round Up" succinct, easy, and clear for the teacher on what/how to implement with the students? If you improved this Round Up, how did you?
11. Is the "Round Up" succinct and clear for the students on how to guide themselves through the implementation? If you improved this Round Up, how did you?

Wrap Up

12. Did you use the Qualitative Student/ Class Data charts? How did you use them?
13. Did you use the Show What You Know assessment? If you improved it, what changes did you make?
14. Did you use the Small Group Evaluation assessment? If you improved it, what changes did you make?

Big Books and Materials

15. How did you use the Big Books in your classroom?
16. Did you find the materials provided in kits were sufficient for your lesson needs?

Is there anything else you would like to add?

## Appendix B

Preschool Teacher Attitudes and Beliefs toward Science Questionnaire (P-TABS)

Please indicate the degree to which you agree or disagree with each statement below by circling the appropriate letters: **strongly disagree** (**SD**), **mildly disagree** (**MD**), **neutral** (**N**), **mildly agree** (**MA**), or **strongly agree** (**SA**).

| | Strongly Disagree | Mildly Disagree | Neutral | Mildly Agree | Strongly Agree |
|---|---|---|---|---|---|
| 1. Preschool science activities help foster children's interest in science in later grades. | SD | MD | N | MA | SA |
| 2. I feel comfortable planning and demonstrating classroom activities related to physical and energy science topics (e.g., force of gravity; gas, liquids, solids). | SD | MD | N | MA | SA |
| 3. More science should be taught in the early childhood classroom. | SD | MD | N | MA | SA |
| 4. It is important for my classroom to have a science area that can be freely explored by children. | SD | MD | N | MA | SA |
| 5. Given other demands, there is not enough time in a day to teach science. | SD | MD | N | MA | SA |
| 6. Experimenting hands-on with materials and objects is how young children learn best. | SD | MD | N | MA | SA |
| 7. Science-related activities help improve preschoolers' approaches to learning. | SD | MD | N | MA | SA |
| 8. I discuss ideas and issues of science teaching with other teachers. | SD | MD | N | MA | SA |
| 9. I use all kinds of classroom materials (e.g., blocks, toys, boxes) for science activities. | SD | MD | N | MA | SA |

UNIVERSITY of HOUSTON

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Institutional Review Boards

APPROVAL OF SUBMISSION

November 18, 2019

Amber Gunner

ascollins3@uh.edu

Dear Amber Gunner:

On November 18, 2019, the IRB reviewed the following submission:

| | |
|---|---|
| Type of Review: | Initial Study |
| Title of Study: | WHAT ARE PRE-K EDUCATOR'S PERCEPTIONS OF PROFESSIONAL DEVELOPMENT IN SCIENCE CONTENT AND PEDAGOGY |
| Investigator: | Amber Gunner |
| IRB ID: | STUDY00001954 |
| Funding/ Proposed Funding: | Name: Unfunded |
| Award ID: | |
| Award Title: | |
| IND, IDE, or HDE: | None |
| Documents Reviewed: | • HRP-503 Amber Gunner Amended, Category: IRB Protocol;<br>• Permission for Data, Category: Letters of Cooperation / Permission; |
| Review Category: | Exempt |
| Committee Name: | Not Applicable |
| IRB Coordinator: | Sandra Arntz |

The IRB approved the study on November 18, 2019 ; recruitment and procedures detailed within the approved protocol may now be initiated.

As this study was approved under an exempt or expedited process, recently revised regulatory requirements do not require the submission of annual continuing review documentation. However, it is critical that the following submissions are made to the IRB to ensure continued compliance:

- Modifications to the protocol prior to initiating any changes (for example, the addition of study personnel, updated recruitment materials, change in study design, requests for additional subjects)

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- Reportable New Information/Unanticipated Problems Involving Risks to Subjects or Others
- Study Closure

Unless a waiver has been granted by the IRB, use the stamped consent form approved by the IRB to document consent. The approved version may be downloaded from the documents tab.

In conducting this study, you are required to follow the requirements listed in the Investigator Manual (HRP-103), which can be found by navigating to the IRB Library within the IRB system.

Sincerely,

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